NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

TERRACE

(Ft.)

CODE 600

DEFINITION

An earth embankment, a channel, or a combination ridge and channel constructed across the slope.

SCOPE

This standard covers the planning and design of all types of terraces. It does not apply to diversions.

PURPOSE

Terraces are constructed to (1) reduce slope length, (2) reduce erosion, (3) reduce sediment content in runoff water, (4) intercept and conduct surface runoff at a nonerosive velocity to a stable outlet, (5) retain runoff for moisture conservation(6) prevent gully development, (7) reform the land surface, (8) improve farmability, (9) reduce flooding, or (10) improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where (1) water erosion is a problem, (2) there is a need to conserve water, (3) the soils and topography are such that terraces can be constructed and terraced land can be farmed with a reasonable effort, (4) a suitable outlet can be provided, or (5) runoff and sediment damage land or improvements downstream or impair water quality.

DESIGN CRITERIA

Terrace Spacing

Terrace spacing will be designed to control either gully or concentrated flow erosion or sheet and rill erosion.

Maximum allowable spacing to control gully or concentrated flow erosion

By major soil series.

1. For the following listed soils and similar deep or moderately deep soils with silty and loamy subsoils with erodibility factor (K) 0.32 or lower, use Table 1.

Alcester	Dawes	Keith	Ortello
Alice	Dickinson	Kenesaw	Otero
Alliance	Duroc	Kennebe	Paka
Altvan	Geary	Keota	Ponca
Anselmo	Goshen	Kuma	Ronson
Ascalon	Grigston	Lancaster	Rosebud
Bayard	Haxtun	Loretto	Sarben
Bazile	Hersh	Malcolm	Satanta
Betts	Hobbs	Marshall	Trent
Blendon	Holder	Monona	Tripp
Bridgeport	Holdrege	Moody	Tuthill
Bridget	Holt	Morrill	Uly
Chappell	Hord	Muir	Ulysses
Cheyenne	Jansen	Napier	Vebar
Clarno	Jayem	Nora	
Cozad	Judson	Ogalala	
Creighton	Kadoka	O'Neill	

TABLE 1

Maximum Slope %	Horizontal and Vertical Spacings (FT)			
	Conventional Farming Low Residue		Conservation Tillage	
	VS	HS	VS	HS
1	2.7	270	3.0	300
2	4.2	210	4.8	240
4	7.2	180	8.4	210
6	9.0	150	10.8	180
8	9.6	120	12.0	150
10	11.0	110	12.0	120
12	12.0	100	13.2	110
14	14.0	100	14.0	100

Note: Where slopes steeper than 14% must be terraced, use 100-feet horizontal spacing with appropriate vertical interval.

2. For the following listed soils and similar deep soils with moderately fine-textured subsoils with erodibility factor (K) of 0.37, use Table 2.

Adair	Fillmore	Mariaville	Wood River
Bufton	Labette	Norrest	Wymore
Butler	Labu	Pawnee	
Crete	Longford	Promise	

TABLE 2

Maximum Slope %	Horizontal and Vertical Spacings (FT)			
	Conventional Farming Low Residue		Conservation Tillage	
	VS	HS	VS	HS
1	2.4	240	2.7	270
2	3.6	180	4.2	210
4	6.0	150	7.2	180
6	7.8	130	9.0	150
8	8.8	110	9.6	120
10	10.0	100	11.0	110
12	12.0	100	12.0	100

3. For the following listed soils and similar deep or moderately deep soils with fine-textured subsoils with erodibility factor (K) 0.43 and 0.49, use Table 3.

Colby	Ida	Mitchell
Crofton	Mayberry	

TABLE 3

Maximum Slope %	Horizontal and Vertical Spacings (FT)			
	Conventional Farming Low Residue		Conservation Tillage	
	VS	HS	VS	HS
1	2.1	210	2.4	240
2	3.0	150	3.6	180
4	4.8	120	6.0	150
6	6.6	110	7.2	120
8	8.8	100	8.8	110
10	10.0	100	10.0	100

The drainage area above the top terrace shall not exceed the area that would be drained by a terrace of equal length with normal spacing for the same soil.

Spacings as listed under “Conventional Farming” are cropland fields tilled by the conventional method of plowing, discing, or harrowing and where residues are less than 30 percent ground cover at crop planting times.

Spacings as listed under “Conservation Tillage” are for cropland fields tilled according to Technical Guide Standard 329.

If the field conditions are not identified in the preceding tables the following equation can be used to determine maximum spacing needed to control concentrated flow erosion.

$$V.I. = xs + y \quad or \quad H.I. = (xs + y)\left(\frac{100}{s}\right)$$

Where: V.I. = vertical interval in feet

H.I. = horizontal interval in feet (See Figure 3) x = a variable with values from 0.4 to 0.8

s = land slope in feet per 100 feet

y = a variable with values from 1.0 to 4.0 feet

Values of “x” for different zones are shown in Figure 4. Values of “y” are influenced by soil erodibility, cropping system, and crop management practices. A value of 1.0 should be selected for easily erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of 4.should be used for erosion resistant soils with tillage systems that leave a large amount of cover

(1.5 tons of straw equivalent) on the surface. A value of 2.5 should be used where one of the above factors is favorable and the other unfavorable. Other values between 1.0 and 4.0 may be used according to the estimated quality of the above factors.

Maximum allowable spacing to control sheet and rill erosion

The Universal Soil Loss Equation (USLE) - The spacing shall not exceed the slope length determined for contour cultivation by using the allowable soil loss, the most intensive use planned, and the expected level of management.

These maximum limits may be exceeded when making adjustments as indicated below. Spacing may be increased as much as 10 percent to provide better alignment or location, to adjust for farm machinery, or to reach a satisfactory outlet. Spacing may be increased an additional 10 percent for terraces with underground outlets. The spacing should be adjusted to provide for an even number of trips for anticipated rowcrop equipment and maximum opportunity for changing row widths. The likelihood of benching of steep slopes by tillage, land forming, and erosion should be considered when determining the terrace interval. The calculated slope between terraces should reflect the as-built situation.

Level Terraces for Erosion Control and Water Conservation—terrace spacing shall be determined as above except the maximum horizontal spacing may not exceed 600 feet. An “x” value of 0.8 may be used for all level terraces used primarily to impound water.

Terraces on Noncropland—Maximum spacing will be governed by the capacity requirement.

For “Flat-Channel Terraces”, add to the horizontal spacing, obtained from the appropriate table, the width of the flat channel as shown in Figure 2. Use vertical interval corresponding to the adjusted horizontal interval.

Alignment

Terraces shall be made parallel when feasible and as parallel as practicable in all cases. Curves should be long and gentle to accommodate farm machinery. Land -forming, extra cut or fill along the terrace line, multiple outlets, variations in grade, channel blocks and other methods are to be used to achieve good alignment.

Capacity

The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terraces with underground outlets, the capacity shall be increased by the estimated 10-year sediment accumulation unless provisions are made to maintain the design capacity through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have capacity to control a storm of a frequency consistent with the potential hazard involved. When the capacity is determined by the formula Q = AV and the “V” is calculated by using Manning’s formula, an “n” value of 0.06 shall be used.

Cross section

The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. The ridge height shall include a reasonable settlement factor. The ridge shall have a minimum width of 3 feet at the design elevation. The minimum cross-sectional area of the terrace channel for gradient terraces shall be 8 square feet for land slopes of 5 percent or less, 7 square feet for slopes from 5 to 8 percent, and 6 square feet for slopes steeper than 8 percent. The opening at the outlet end of gradient and open end level terraces shall have a cross section equal to that specified for the terrace channel. All terraces shall conform to one of the “typical terrace cross section” shown in Figure 1 on page 600-10 or Figure 2 on page 600-11.

Height

Effective design height is defined as the height that either stored or conveyed water will not exceed for the required design storm. The effective design height is measured according to one of the following:

1. Situation 1

   (Where no additional height has been added for settlement.) The effective design height will be the distance from the channel to the elevation where the terrace is 3 feet wide.

2. Situation 2

   (Where additional height has been added for settlement.) The effective design height will be the distance from the channel to the elevation where the terrace is 3 feet wide minus the height that has been added for settlement.

Total height is defined as the effective design height plus the height added to compensate for settlement plus the height added for the peak of the ridge.

1. Broadbase and steep backslope terraces:

   When terraces are constructed in whole or in part by methods employing longitudinal equipment travel on the embankment, the minimum effective design height will be 0.8 foot for terraces constructed for contour furrow irrigation and 1.3 feet for other types. The minimum total height from channel to peak of ridge will be 1.2 foot and 1.7 feet respectively.

2. Flat channel terraces:

   The minimum effective design height will be 1.3 feet. The minimum total height will be 1.6 feet.

3. Broadbase, steep backslope, and flat channel terraces:

   When terraces are constructed by methods employing no equipment travel on the embankment, additional height may need to be added to the effective design height to compensate for settlement.

4. Narrow base terraces:

   The minimum effective design height will be 1.3 feet. A minimum of 0.7 foot will be added to the effective design height to compensate for settlement. An additional 0.8 foot will be added for the peak of the ridge. Therefore, the minimum total height from channel to peak of ridge will be 2.8 feet.

End Closures

Level terraces may have open ends or partially closed ends if adequate outlets are provided. Complete end closures will be used only on soils where the stored water will be absorbed by the soil without appreciable crop damage or underground outlets are provided.

When terraces with closed or partially closed ends are specified, the end closures must be installed before the terraces are considered complete.

Careful planning of the overtopping area of all terraces with storage or end closures is essential. Site conditions shall be considered when determining whether the overtopping area should be at the end closure or at some other location along the terrace ridge.

Partial end closures shall not be more than half the effective height of the terrace ridge. Full end closures are those more than half the height of the ridge. The cross section of the closures may be less than the terrace cross section.

Terrace Slope Length

The length of terrace slopes [cut slopes (if any), frontslope, and back-slope] should be designed to fit the farmer's machinery and his wishes. The minimum length of all farmable slopes will be 13.5 feet. As a matter of safety, the frontslope length of push-up terraces should be approximately 1.5 feet longer than the width of the farm equipment to be used. The backslope of a terrace intended to be farmed to cultivated crops shall not be steeper than 6:1.

Channel Grade

Channel grade shall be determined by one of the following methods:

1. Maximum channel grade in the lower reaches of the channel should not exceed 0.6 ft per 100 ft of length.

2. Maximum channel velocity shall be nonerosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 ft/sec; for average soils, 2.0 ft/sec; and for easily erodible soils, 1.5 ft/sec. Velocities are to be computed by Manning's formula, using an "n" value of 0.035. Grades in the terrace channels shall not 2.0 ft/100.

Channel grades may be uniform or variable. Channel velocity shall not exceed that which is nonerosive for the soil and planned treatment. For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment. Steeper grades, that exceed the restrictions shown in A and B, may be designed below the maximum storage elevation of underground outlets. When maximum grades are exceeded, erosion can occur in these areas and require extra maintenance. Minimum grades are to be such that ponding in the channel due to minor irregularities will not cause serious damage to crops or delay in field operations.

Flat Channel Widths

Figure 2 shows the widths of channel - "W" - to be used with various row spacing and equipment on given land slopes. In "continuous wheat-fallow" areas, or in those areas where both row crops and close-sown crops may be grown, adjustments may be made in channel width, providing the width is not less than 60 feet for 1 percent land slope, 48 feet for 2 percent, 36 feet for 3 percent, and 24 feet for 4 percent. The technician and farmer should agree, before construction, on the design (planned) length of terrace slopes and width of flat channels.

Terrace Lengths

The volume of water stored in level terraces is proportional to the length. Therefore, it is necessary that the length be held within reason so that damage in case of a break will be minimal. Level terrace length shall not exceed 3,500 feet unless the channel is blocked at intervals not exceeding 3,500 feet. Gradient terrace length will normally be controlled by capacity and the nonerosive velocity requirement.

Outlets

All terraces must have adequate outlets.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway or vegetated area. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets are to be installed and vegetated before terrace construction, if necessary, to provide a stable, nonerodible outlet or to insure establishment of vegetative cover. The water surface in the terrace shall not be lower than the water surface in the outlet at their junction when both are operating at design flow.

Underground outlets may be used with gradient or level terraces. The outlet consists of an intake and underground conduit. An orifice plate, increase in conduit size, or other feature shall be installed in each outlet as needed to control the release rate and prevent excessive pressure when more than one terrace discharges into the same conduit. The discharge, when combined with the storage, is to be such that a 10-year frequency, 24-hour storm will not overtop the terrace, and growing crops will not be damaged significantly by standing water. The release time shall not exceed 48 hours for the design storm. Shorter periods may be necessary for some crops, depending on soil characteristics and water tolerance of crops to be grown.

The underground conduit shall meet the requirements in the Nebraska Technical Guide for UNDERGROUND OUTLET (620). Conduits must be installed deep enough to prevent damage from tillage equipment. The inlet is to consist of a vertical perforated pipe of a material suitable for the intended purpose. The inlet should be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, where necessary, provide for the anticipated accumulation of sediment and subsequent raising of the terrace ridge. The outlet of the conduit shall have adequate capacity for the design flow without erosion. Blind inlets may

be used where they are effective, usually in well drained soils.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration should permit draining the design storm from the terrace channel in a period such that growing crops will not be significantly damaged by standing water.

Combinations of different types of outlets may be used on the same system to maximize water conservation and to provide for economical installation of a more farmable system.

Safety and Maintenance

A program shall be established for maintaining terrace capacity, storage, ridge height, and outlets. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is in the lowest place. Inlets damaged or cut off by farm machinery must be replaced or repaired immediately.

Terrace ridges can be very hazardous. For this reason, some farmers prefer steep front slopes, thus keeping machinery away from the steep back slopes. All cut and fill slopes that are to be farmed must be no steeper than those on which farm equipment can operate safely. Any hazards must be brought to the attention of the responsible person.

Vegetation

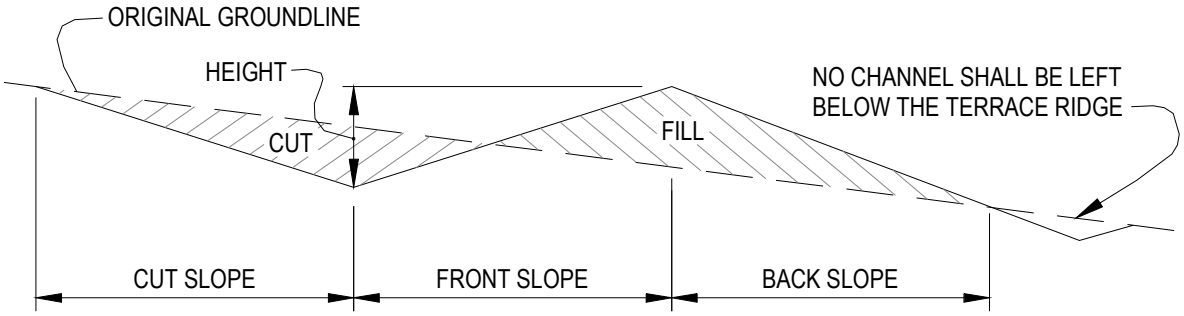
Steep backslope terraces (and steep frontslope, if used) shall be established to grass as soon as practicable after construction. The sod shall be maintained and trees and brush controlled by chemical or mechanical means. Specification (342) CRITICAL AREA PLANTING will be used to determine seeding mixtures.

PLANS AND SPECIFICATIONS

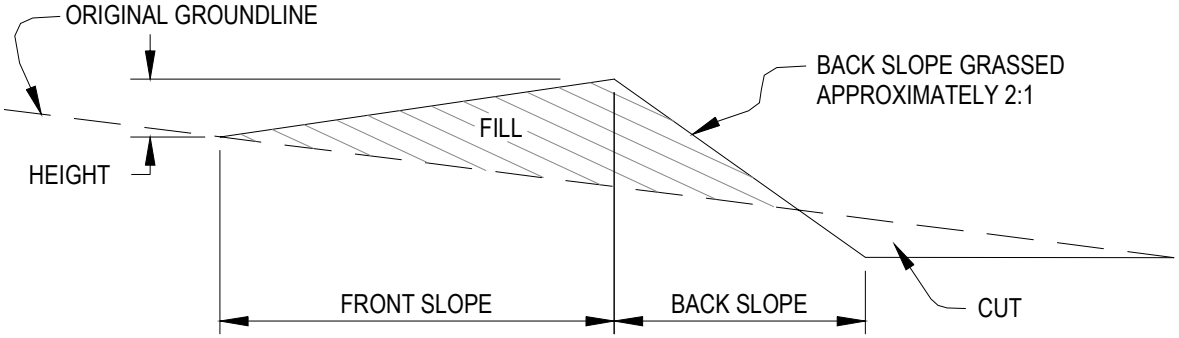
Plans and specifications for installation of terraces shall be in keeping with this standard and shall describe the requirements for application of the practice to achieve its intended purpose.

Figure 1

BROADBASE TERRACE

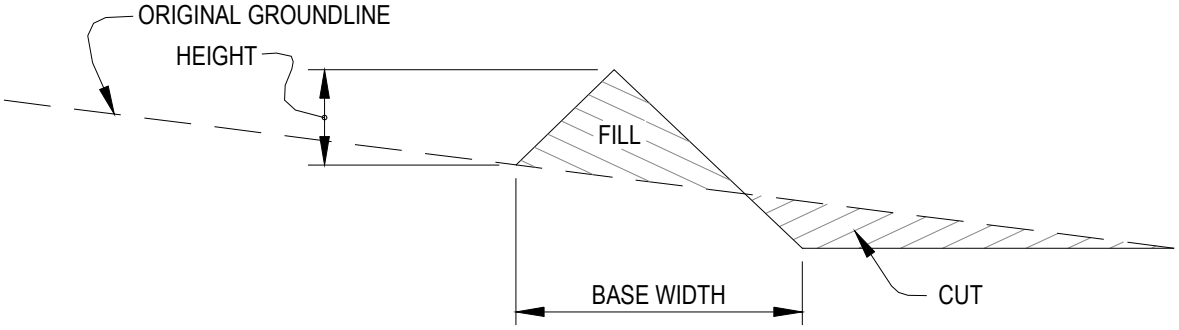


STEEP BACKSLOPE TERRACE



NOTE: SPACING, HEIGHT AND SLOPE LENGTHS TO BE IN ACCORDANCE WITH NATURAL RESOURCES CONSERVATION SERVICE STANDARDS.

NARROW BASE TERRACE

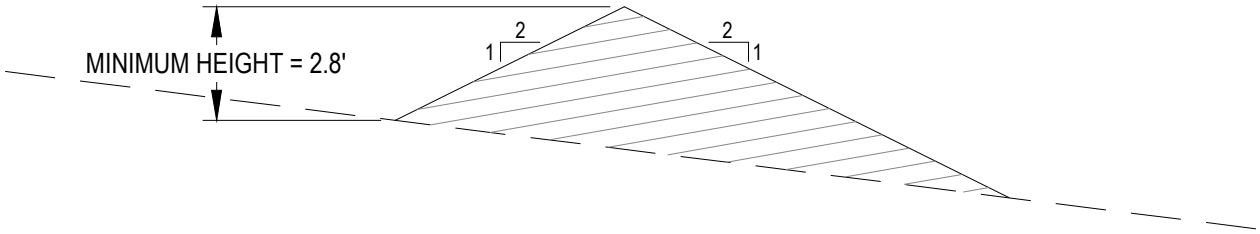


NOTE: 1. FRONT AND BACK SLOPES BOTH GRASSED AND APPROXIMATELY 2:1.

2. SPACING, HEIGHT AND BASE WIDTH ARE TO BE IN ACCORDANCE WITH NATURAL RESOURCES CONSERVATION SERVICE STANDARDS.

Figure 2

NARROW BASE TERRACE



FLAT CHANNEL TERRACE

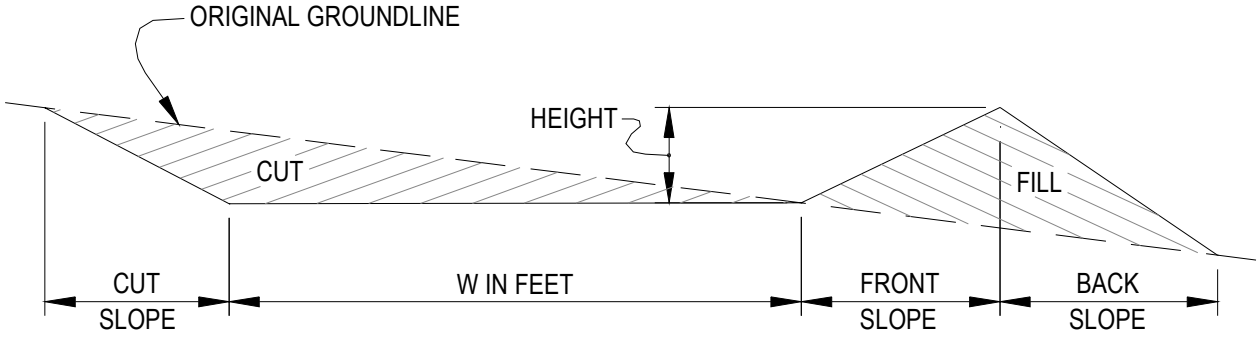


TABLE OF CHANNEL WIDTHS

SLOPE	IMPLEMENT SPACING AND ROW		
	30" SPACING 4 ROW (W IN FEET)	40" SPACING 6 ROW (W IN FEET)	30" SPACING 6 ROW (W IN FEET)
1	70	67	75
2	50	54	60
3	40	40	45
4	30	27	30

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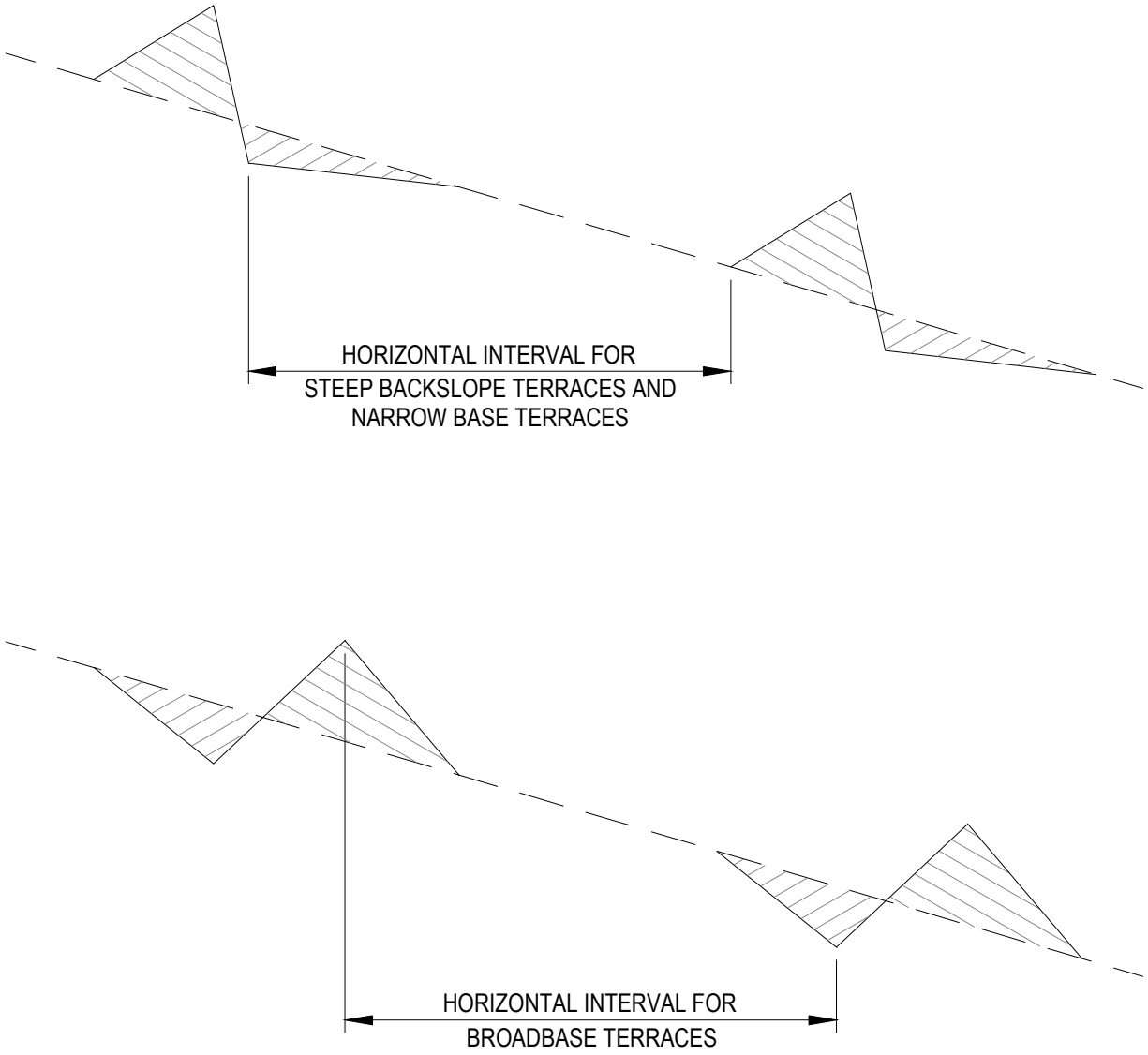
Figure 3


HORIZONTAL INTERVAL FOR
STEEP BACKSLOPE TERRACES AND
NARROW BASE TERRACES
HORIZONTAL INTERVAL FOR
BROADBASE TERRACES

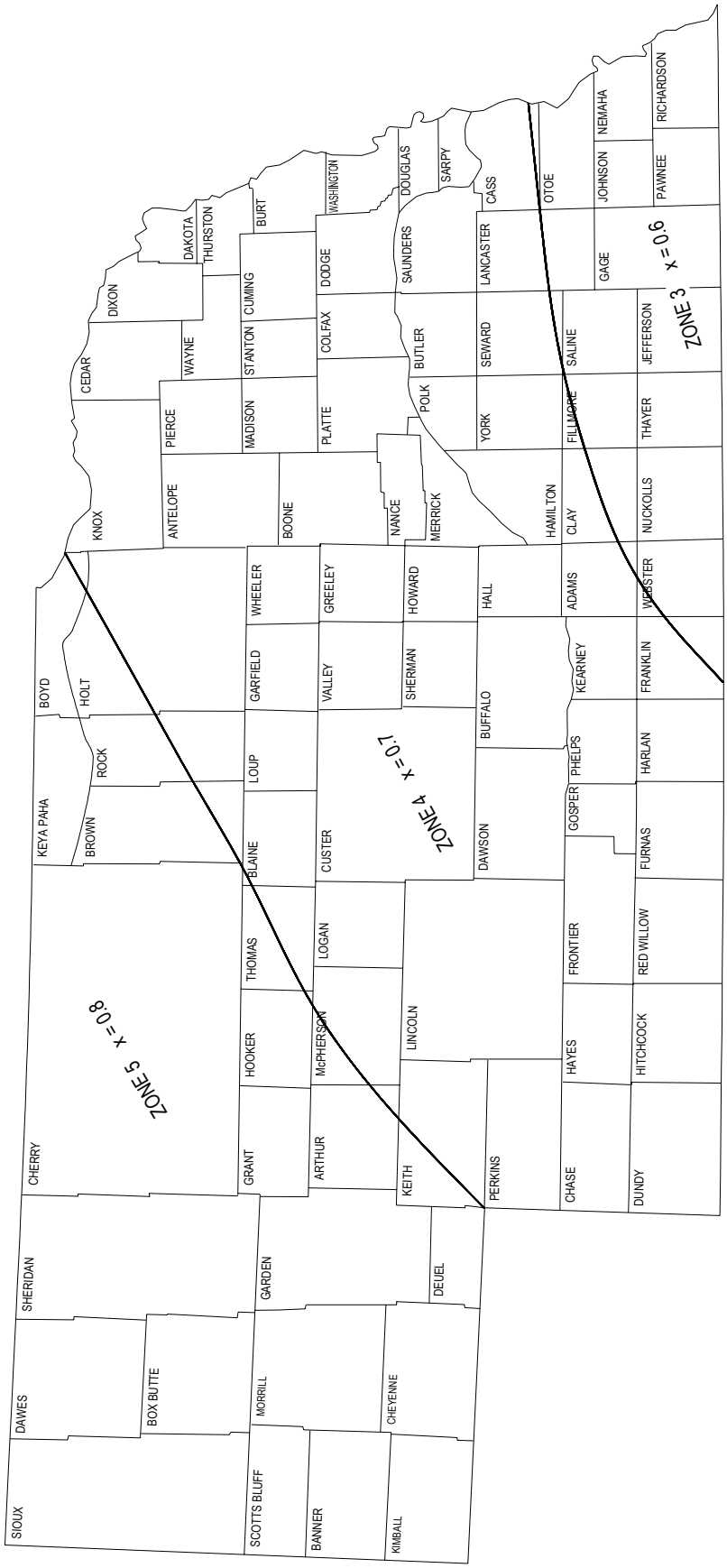


FIGURE 4

VALUES OF x IN EQUATION: V.I.= xs + y OR H.I. = (xs + y) ($\frac{100}{s}$)